Prospects for the calibration of cosmics in SNO

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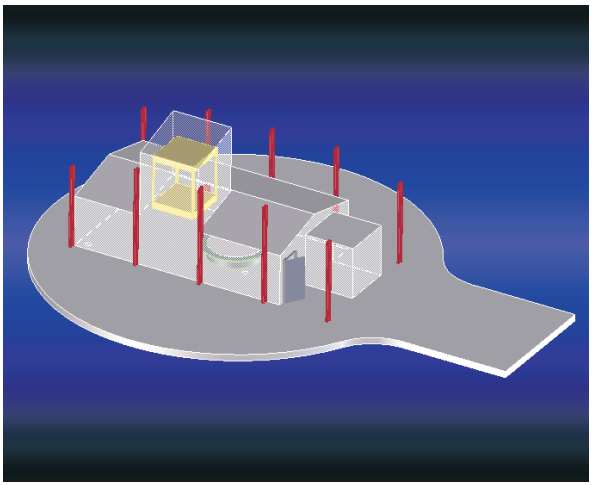

FIG. 1: View of the SNO deck clean room laid above the detector. The elevated yellow structure is a mock-up of the foreseen muon calibration system. Illustrated is a setup consisting of two chambers of approximate size 2×2 m^2 and 2 m apart.

Atmospheric neutrino studies in SNO require a good knowledge of the muons traversing the detector.

The track reconstruction algorithm currently in use has been developed out of a Monte Carlo simulation of muons that is assessed on regular data [1]. Since no independent calibration data is available for cosmics the reconstruction of muons relies on the trust we have that the simulation effectively describes the quantities involved. In particular it is unknown what kind of sytematics errors or biases are associated with the simulation of muons.

It would be desirable to dispose of a sample of muon events that would be measured in an independent way in order to tune the performance of the Monte Carlo. A determination of the muon direction with a typical resolution of the order of 1 degree is sufficient to confront the Monte Carlo predictions. On the other hand no energy measurement can be reasonably considered without an important setup of equipment.

Such a sample can be provided by operating a standard setup of tracking chambers like the ones commonly used for test beam runs in high energy physics (so called *muon trackers*). The advantage of this option is that (1) this type of device is common and designed to meet specifications well beyond what is needed in our situation (2) no or minimum construction would be required, therefore saving time and costs. Contacts with collaborations at Fermilab indicate that drift chambers can be available to us for this purpose.

The space available on the deck above the detector at SNO is limited by various hardware and support structures. Some free space above the detector's neck can accommodate such a tracking device. A strawman design consisting of 2 chambers

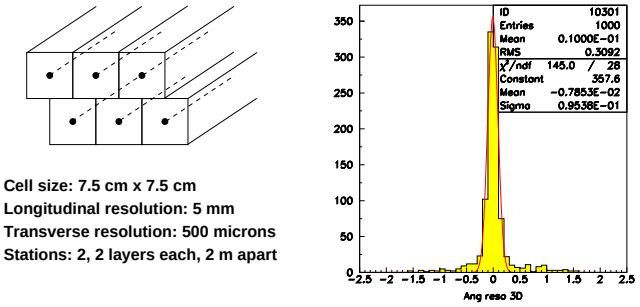

FIG. 2: (LEFT) Characteristics of the drift tubes used at Fermilab and implemented in a toy Monte Carlo. (RIGHT) Angular resolution of reconstructed 3D tracks simulated by Monte Carlo with the setup described in the text. Abcissa is in [degree].

of size 2×2 m^2 and mounted 2 m apart depicted on Figure 1 is being discussed.

The flux of cosmic muons across the detector at SNO's depth, 6800 ft, is about 72 events/day. The design under consideration would record 2 muons/day with a range of impact parameters covering the whole detector. A running period of 3–4 months would allow to collect large enough a sample to perform an independent tuning of the muon simulation and track reconstruction algorithm.

The standard SNO DAQ system has enough available spare channels in principle to accommodate the readout of the tracker O(500 channels) and without overloading the overall data stream.

Based on the characteristics of existing chambers [2] a standalone simulation has been written to assess different configurations of the tracker. The main instrumental effects have been folded in such as mirror hits, modest spatial resolutions and modest individual tube detection efficiencies. In a configuration with 2 tracking stations, Figure 2 shows a quite satisfactory angular resolution of 1/10 of a degree for 3-dimensional tracks using a realistic reconstruction algorithm.

The current effort is being pursued towards having these chambers possibly installed at the SNO site on the short term.

[1] N. Tagg, Thesis, University of Guelph (2001).
[2] Internal note 6362, CDF collaboration (2002).